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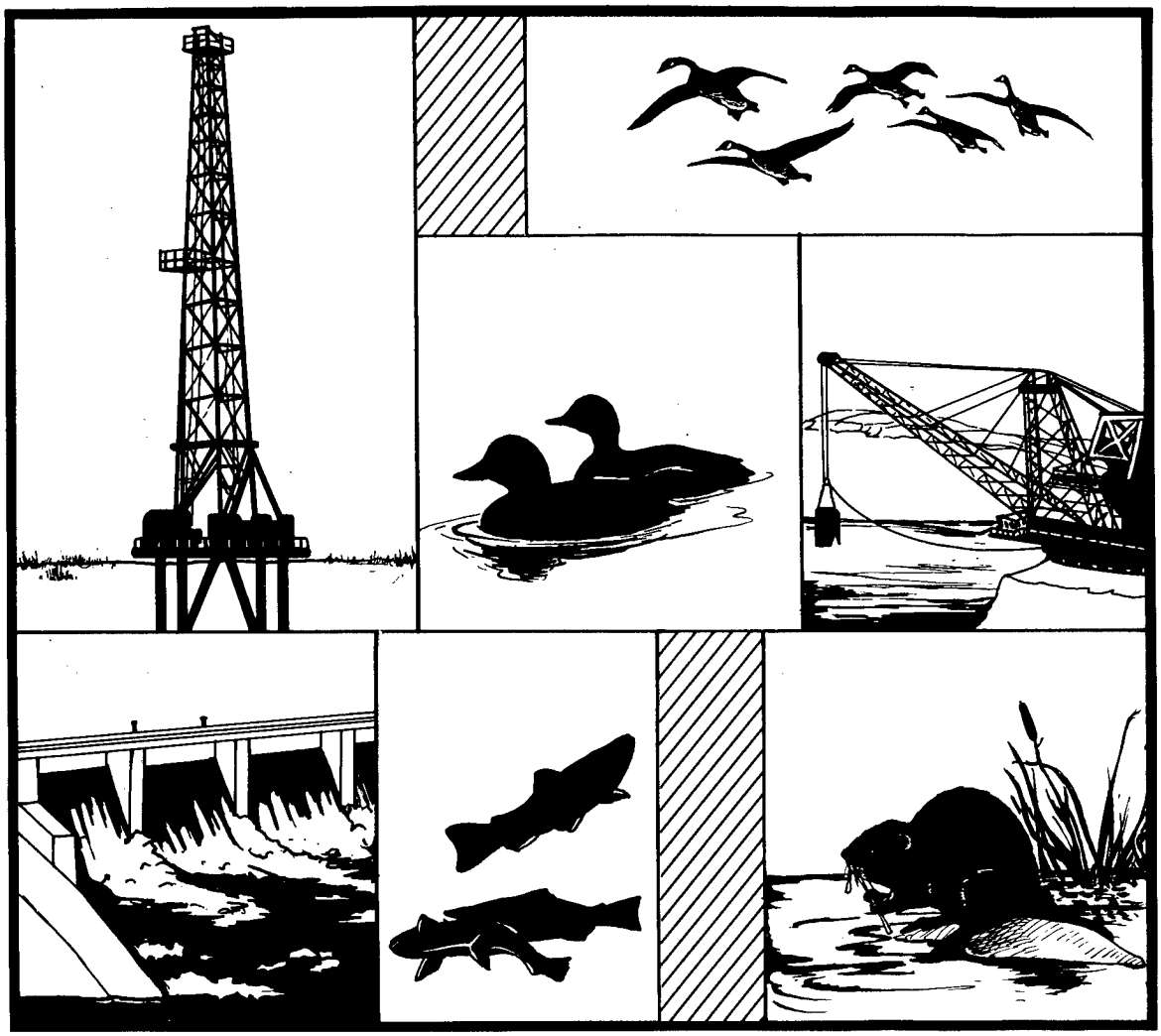

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ASSESSING THE RELATIONSHIP BETWEEN SECTION 404 AND WETLAND LOSSES: A FEASIBILITY STUDY

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INTRODUCTION

The primary objective of the Clean Water Act of 1977 (33 U.S.C. 1251) is to restore and maintain the physical, chemical, and biological integrity of the Nation's waters. Section 404 of the Act regulates the discharge of dredged or fill materials into wetlands and represents the primary Federal authority for regulation of wetland alterations. Since its inception, the Section 404 program has been controversial in regard to the extent to which it was intended to provide wetlands regulation.

Section 404 requires those who wish to discharge dredged or fill material into waters of the United States, which include many wetlands, to first obtain a Federal permit. The Environmental Protection Agency (EPA) has overall responsibility for administration of the Section 404 program and promulgates guidelines that must be followed in issuing permits. In addition, EPA has the final authority to prohibit specific discharges if the environmental impacts are unacceptable. The U.S. Army Corps of Engineers (Corps) issues Section 404 permits, which can be of two types. Individual Permits are issued following case-by-case reviews of proposed discharges. General Permits, which can be either nationwide or regional in scope, are authorized by the Corps for categories of activities that are similar in nature and that have only minimal individual and cumulative adverse environmental impacts. EPA, the National Marine Fisheries Service (NMFS), the Fish and Wildlife Service (Service), and State natural resource agencies review and comment on permit applications and offer recommendations on appropriate mitigation measures. Although comments from the Service and other natural resource agencies are advisory in nature (EPA's veto authority excepted), they can serve as the basis for modifying, conditioning, or denying a Section 404 permit.

In 1986, in a survey conducted by the National Ecology Research Center, Service personnel indicated interest in additional information concerning both wetland trends and the impacts of activities authorized by the Corps under Section 404 (Roelle 1986). Although there is some information concerning wetland losses for certain geographic areas and for the Nation as a whole (Frayer et al. 1983; Tiner 1984), there appears to be little information on how these losses relate to the Section 404 permitting process. The primary objective of this study was to determine the feasibility of estimating wetland losses in relationship to Individual and General Permits issued under Section 404. A secondary objective was to assemble data on acceptance and implementation of specific mitigation recommendations offered by the Service and other natural resource agencies in connection with development activities on wetlands examined.

At present, 26 categories of Nationwide Permits have been authorized by the Corps. Nationwide Permit 26 was of particular interest in this study because it specifically authorizes discharges into wetlands under certain circumstances (see Figure 1 and related text for a more complete discussion of circumstances under which Nationwide Permit 26 is applicable). All subsequent references to Nationwide or General Permits pertain to Nationwide Permit 26.

PROCEDURES

BASIC APPROACH

The basic approach was to attempt to obtain a complete inventory of changes in wetland area in a defined geographic location for the time period spanning the late 1970's to the mid to late 1980's. The late 1970's was chosen as the starting point for the study because the Clean Water Act of 1977 provided the first authorization for General Permits; some other parts of the permit program predate the Clean Water Act. Ideally, a complete inventory of wetland changes would include information on: (1) area of wetlands that existed at the beginning of the period; (2) area lost during the period that was authorized by General Permits and Individual Permits; (3) area lost due to illegal activities (i.e., activities involving a deposition of dredged or fill material but not authorized by a permit); (4) area lost to activities not requiring a permit (i.e., activities not involving a deposition of dredged or fill material); (5) area lost at locations considered by natural resource agencies as being wetlands but not so considered by the Corps; and (6) area gained through mitigation or other wetland creation or restoration activities.

STUDY AREA SELECTION

The geographic areas considered for this feasibility study were the Cherry Creek Basin, south of Denver, and the Fort Collins 7½' quadrangle, located in eastern Larimer County, Colorado. National Wetlands Inventory (NWI) maps were used to establish baseline conditions. For the two study areas considered, NWI coverage is from 1975, which was judged to be acceptably close in time to implementation of the Clean Water Act. NWI maps were obtained and preliminary field investigations were undertaken to determine the feasibility of on-site wetlands inspection. These investigations revealed several problems in regard to the Cherry Creek study area: (1) many wetlands present in 1975 were not visible on the 1:80,000-scale black and white photography that was used, and were thus not shown on the NWI maps; (2) the predominant brush/shrub cover made wetland location and inspection difficult and time-consuming; and (3) access was limited by the irregularly distributed roads in the area. For these reasons, it was decided to conduct the feasibility study in the Fort Collins area. Field investigations there indicated that the NWI maps were more complete, site inspection was more feasible due to the predominance of grassland cover, and access was easier due to the extensive road network.

DATA COLLECTION

The 1975 NWI map for the Fort Collins 7½' quadrangle was digitized, and a Map Overlay and Statistical System (MOSS) data base was constructed. MOSS was used to compute area (acres) for all polygonal wetlands and linear extent (miles) for all nonpolygonal wetlands. The Cartographic Output System was used to generate a 1:24,000-scale mylar overlay of the wetland map, which was employed in combination with a U.S. Geological Survey topographic map to locate wetlands in the field.

In order to completely understand the relationship between Section 404 and wetland alterations, it is desirable to know not only area lost, but also relative rates of loss (e.g., are wetlands whose alteration would typically be covered by Individual Permits lost at a greater or lesser rate than wetlands whose alteration would typically be covered by Nationwide Permit 26?). Unfortunately, the status of jurisdictional wetlands under Section 404 depends not only on characteristics of the wetland itself (size, geographic location) but also on the area impacted (Figure 1). In addition, if the wetland is viewed as particularly important, resource agencies can request that an Individual Permit be required for activities that would normally be covered by Nationwide Permit 26. Thus, it is not possible to develop a completely accurate classification of wetlands according to their status under Section 404 on the basis of a map alone. However, using a map and some ancillary data on streamflows, it is possible to classify wetlands into categories that are closely related to Section 404.

1. Wetlands adjacent to streams with >5 cfs average annual flow and wetlands >10 acres in size. Discharges of dredged or fill material in wetlands adjacent to such streams always require an Individual Permit. Discharges in wetlands >10 acres might require either an Individual Permit or a General Permit, depending on the area impacted.

2. Wetlands between 1 and 10 acres and either above the headwaters (i.e., adjacent to a stream with <5 cfs average annual flow) or isolated (i.e., not part of a surface tributary system to interstate waters or navigable waters of the United States). Discharges of dredged or fill material in these wetlands would usually be covered by Nationwide Permit 26 unless a resource agency requests otherwise. Notification of the Corps prior to any discharge is required.

3. Wetlands <1 acre and either above the headwaters or isolated. Wetlands in this category are technically covered under Nationwide Permit 26. However, notification of the Corps prior to any discharge is not required. Such wetlands are therefore effectively unregulated, and alterations to them are henceforth referred to as not requiring a permit (in the sense that there would likely be no record of such alterations in agency files).

All polygonal wetlands shown on the 1975 NWI maps of the Fort Collins quadrangle were classified into one of the above categories. All wetlands occurring in the historic floodplain of the Cache La Poudre River were considered to be adjacent to a stream with >5 cfs average annual flow. One wetland next to a large irrigation canal was also placed in this category. All other streams in the area were determined, from information provided by the Corps, to have an average annual flow <5 cfs; thus, all other wetlands were considered to be either above the headwaters or isolated. Areas calculated in MOSS were used as the measure of wetland size. No attempt was made to classify nonpolygonal wetlands because the physical area of these wetlands cannot be determined without field measurements.

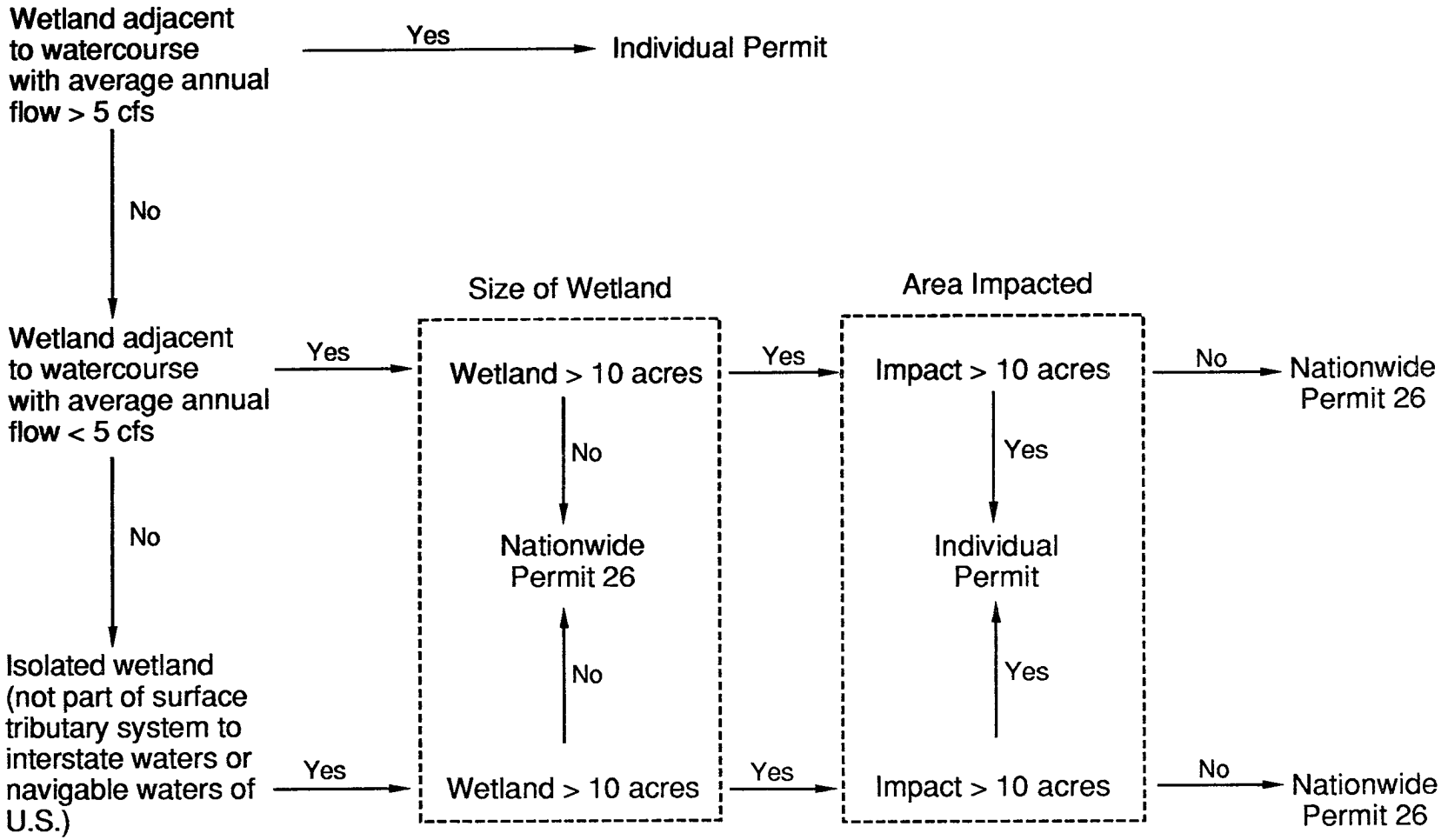

Figure 1. Typical treatment of jurisdictional wetlands under Section 404. Resource agencies can request that an Individual Permit be substituted for Nationwide Permit 26 in cases where the wetland is viewed as being particularly important.

Copies of all available Public Notices, agency comments, and permits were obtained from the Corps office in Omaha, Nebraska; the Colorado Division of Wildlife (CDOW) office in Fort Collins; and Service offices in Grand Junction and Golden, Colorado. These records were used to identify permitted wetland alterations and to assemble information on acceptance and implementation of specific mitigation recommendations offered by natural resource agencies in connection with development activities on wetlands examined (i.e., what mitigation recommendations were made, whether they were incorporated into permits by the Corps, and whether they were implemented by the permittee).

Each wetland in the study area was visited to determine whether any alteration had occurred since 1975. In cases where there were alterations, the apparent cause and approximate area were noted, as were any observable mitigation measures. Observed alterations were then compared to the permit record and to the classification described above to determine losses in the various categories. In cases where entire wetlands were lost, the area was assumed to be that calculated in MOSS. Areas of permitted losses were assumed to be as stated in the permits. For partial, unpermitted losses, field estimates of area lost were used. In addition, all "new" wetlands (i.e., wetlands not shown on the 1975 maps) encountered during the site visits were noted. However, no attempt was made to search the study area systematically for "new" wetlands.

RESULTS

The 1975 NWI maps showed about 1,356 acres of polygonal wetlands (Table 1) and 70 miles of nonpolygonal wetlands (Table 2) in the study area. The wetland classification used in these tables follows Cowardin et al. (1979). Brief descriptions of the codes can be found in the Appendix. Irrigation reservoirs (L1OWKZ and L2OWKZ) composed roughly half the area of polygonal wetlands. Irrigation canals (R4SBKC) composed nearly half the linear extent of nonpolygonal wetlands. For purposes of comparison, if the average width of nonpolygonal wetlands were 20 ft, they would occupy a surface area of about 170 acres.

In 1988, 66.2 acres of polygonal wetlands mapped in 1975 were no longer present (Table 3). Losses were greatest (34.2 acres, or 37.7% of the area present in 1975) among wetlands mapped as palustrine emergent saturated/semipermanent/seasonal (PEMY). Because of the difficulty of estimating surface area in the field, and because there was no systematic effort to locate all "new" wetlands, it was not possible (with the methods used in this study) to obtain an accurate estimate of wetland gains during the period 1975-1988. However, over 200 acres of "new" wetlands were encountered during field investigations. A high proportion of these were palustrine open-water areas resulting from sand and gravel extraction along the Cache La Poudre River. Other observed gains resulted primarily from construction of ponds for landscaping. Mitigation resulted in creation of only 2.5 acres, all at a single site in the PEMY category. No detailed investigations of the mitigation site were conducted; however, the mitigation effort appeared to have been largely successful. Field investigations revealed no losses or gains of nonpolygonal wetlands.

Table 1. Area of polygonal wetlands shown on 1975 National Wetlands Inventory maps.

Wetland type	Area (acres)	Number of polygons	Percent of total wetland area
Lacustrine			
L1OWKZ	655.9	8	48.4
L2OWKZ	25.6	1	1.9
Palustrine emergent			
PEM/FLW	6.7	1	0.5
PEMC	0.9	1	0.1
PEMW	8.1	1	0.6
PEMY	90.8	24	6.7
Palustrine forested			
PFLKC	0.9	1	0.1
PFLKY	25.4	6	1.9
PFLW	0.9	2	0.1
PFLY	7.0	7	0.5
PFOW	231.3	24	17.1
Palustrine open water			
POWF	52.1	29	3.8
POWKF	32.2	5	2.4
POWKH	16.7	1	1.2
POWKZ	170.4	33	12.6
POWZ	6.0	8	0.4
Palustrine scrub/shrub			
PSS/EMC	1.1	1	0.1
Riverine			
R2BBW	1.0	1	0.1
R2OWZ	23.2	1	1.7
Total	1356.2	155	(100)

Table 2. Length of nonpolygonal wetlands shown on 1975 National Wetlands Inventory maps.

Wetland type	Length (miles)	Number of segments	Percent of total length of wetlands
Palustrine emergent			
PEMY	19.1	40	27.4
Palustrine forested			
PFLY	.1	1	.1
PFOW	4.0	10	5.7
Palustrine open water			
POWF	.2	2	.3
POWZ	.2	1	.3
Palustrine scrub/shrub			
PSS/EMC	.7	5	1.0
Riverine			
R2OWZ	9.8	54	14.0
R4SBKC	33.6	18	48.1
R4SBW	2.1	2	3.0
Total	69.8	133	(100)

Table 3. Observed losses of polygonal wetlands, 1975-1988.

Wetland type	1975 area (acres)	Area lost (acres)	Percent of 1975 area lost
PEMY	90.8	34.2	37.7
PEM/FLW	6.7	5.7	85.1
PFOW	231.3	16.5	7.1
POWKF	32.2	6.2	19.3
PFLKY	25.4	2.3	9.1
L1OWKZ	655.9	1.3	0.2
Total		66.2	

The relationship between losses of polygonal wetlands and Section 404 is shown in Table 4. Losses occurred at eight individual wetland sites. Examination of the permit record revealed no information concerning four of these sites.

1. A 21.1-acre site classified as PEMY, of which about 5 acres of degraded wetland remain. The loss appears to have resulted from a combination of fill, street construction, and interruption of seepage losses from irrigation canals.

2. A 6.2-acre site classified as PEMY, none of which currently remains. Although the evidence is scarce, it appears that this site was probably filled. It is presently used for agriculture.

3. A 24.2-acre site composed of 17.5 acres of PFOW and 6.7 acres of PEM/FLW. About half of this site is now occupied by a golf course and an irrigation pond. The other half shows evidence of both drainage and filling. About 1 acre of each wetland type remains.

4. An 11.5-acre site, classified as PEMY, of which all but about 0.2 acres has been filled for an unknown purpose.

Losses at these four sites thus account for 55.8 acres of the 58.6 acres shown in Table 4 in the category "No record of permit." The remaining 2.8 acres of loss in this category occurred at two sites where issued permits covered only part of the area lost. One of these was a 5.0-acre site, classified as PEMY, for which a Nationwide Permit authorized filling 2.7 acres. The other was a 1.8-acre site, classified as PEMY, for which an Individual Permit authorized dredging and filling 1.3 acres. This was the permit that required creation of 2.5 acres of wetland as mitigation.

Table 4. Observed losses of polygonal wetlands classified by treatment under Section 404.

Wetland category	1975 area (acres)	Treatment under Section 404	Area lost (acres)	Percent of 1975 area lost	Percent of total wetland loss
Adjacent to a stream with >5 cfs average annual flow or >10 acres	1231.6	Individual Permit	1.3	0.1	2.0
		Nationwide Permit	2.3	0.2	3.5
		No record of permit	49.6	4.0	74.9
1-10 acres and isolated or above headwaters	108.5	Individual Permit	1.3	1.2	2.0
		Nationwide Permit	2.7	2.5	4.1
		No record of permit	9.0	8.3	13.6
<1 acre and isolated or above headwaters	16.1	No permit required	0.0	0.0	0.0
Total	1356.2		66.2		(100)

The category "No record of permit" in Table 4 may thus include: (1) losses due to illegal activities; (2) losses of nonjurisdictional wetlands (i.e., wetlands mapped by NWI, but not meeting the Corps' wetland definition); and (3) losses covered by permits for which no record could be located. Additional consultation with personnel from the Corps and natural resource agencies could probably resolve some of these uncertainties. However, it seems unlikely that all wetland losses could ever be classified accurately (i.e., some losses would always have to be classified as "unknown" or "no record available").

Losses at the remaining two sites were completely authorized by permits. One involved an Individual Permit to fill 1.3 acres along the bank of an irrigation reservoir, for housing. The other involved a Nationwide Permit to fill an 8.3-acre gravel pit. Only about 2.3 acres have been filled to date.

With respect to the secondary objective of the study, the 2.5-acre wetland creation project mentioned above was the only currently observable mitigation for the wetland alterations examined. There are a variety of reasons that it was not possible to track additional mitigation measures. First, inability to locate all permit records meant that information about recommended and accepted mitigation measures was incomplete. Second, many of the mitigation measures that were identified dealt with activities along the Cache La Poudre River, where annual flooding and resultant streambed changes made it difficult to distinguish natural changes from those due to project or mitigation activities. Finally, available permits contained many mitigation recommendations related to avoiding or minimizing impacts (e.g., perform work in a manner that will minimize increases in suspended solids and turbidity; take care to prevent any petroleum products or chemicals from entering the water), and whose results are not currently observable.

DISCUSSION

The ability to evaluate wetland losses as related to Section 404 of the Clean Water Act can be viewed in terms of four basic questions.

1. Is adequate baseline information available concerning the wetlands that existed at or about the time the Clean Water Act of 1977 was implemented?

2. Can wetlands that existed in 1977 (or thereabouts) be classified as to their status under Section 404? If so, what information is gained, and if not, what is lost?

3. Can wetland alterations that have occurred since implementation of the Clean Water Act be identified and accurately quantified?

4. Is the Section 404 permit record (i.e., Public Notices, resource agency comments, and issued permits) adequate to identify which alterations were permitted and which were not?

BASELINE DATA

With respect to identifying wetlands that existed at or about the time the Clean Water Act was enacted, there is little doubt that NWI maps represent the most complete and comprehensive data set available. However, despite their overall high quality and utility, these maps are not without problems from the perspective of a study of this nature. These problems are basically twofold.

First, accuracy of the maps, in the sense of proportion of existing wetlands actually delineated, is highly dependent on the quality of the aerial photography used. For purposes of expediency, early NWI maps were often produced from available photographs, rather than from photographs obtained specifically for the purpose of identifying and classifying wetlands. Thus, for example, wetland delineation in the Cherry Creek watershed may have been significantly hampered by use of 1:80,000-scale black and white photography. However, this was apparently not a significant problem in the Fort Collins area, where nearly all wetlands encountered on site visits were either delineated on the 1975 maps or obviously created since that time. Furthermore, problems of this nature can be even more important if wetland changes are analyzed by comparing two sets of maps from different time periods. In such cases, the results depend not only on the relative quality of the two sets of photography, but also on variability in photointerpretation and drafting, and differences in hydrologic conditions at the time the photographs were taken.

Second, even the best NWI maps include nonjurisdictional wetlands (i.e., areas not meeting the Corps' wetland definition), because of basic differences in the wetland identification process. In addition, in the absence of relatively detailed on-site investigations, it is impossible to determine which wetlands would meet the Corps' definition. This is further complicated by the fact that the Corps' definition of jurisdictional wetlands has evolved during the period of interest (i.e., 1977 to the present). A wetland considered to be nonjurisdictional in 1977 may be considered jurisdictional today. The recently completed "Federal Manual for Identifying and Delineating Jurisdictional Wetlands" (Federal Interagency Committee for Wetland Delineation 1989) will alleviate some of these kinds of problems in the future.

Despite these difficulties from the perspective of this study, wetlands identified on NWI maps represent areas of interest to management agencies because of their potential and actual resource values. Loss of such areas should therefore be of interest, regardless of the fact that some of these losses may fall outside the jurisdiction of Section 404. Furthermore, even in the worst case, NWI maps probably include a significant proportion of the wetlands that existed at the time the aerial photographs were taken.

CLASSIFYING WETLANDS

As noted earlier, it is clearly not possible to precisely classify the wetlands identified on NWI maps as to their status under Section 404, at least on map-based information alone, because: (1) not all mapped wetlands are considered by the Corps to be jurisdictional wetlands; (2) treatment under Section 404 depends on the nature and extent of the proposed development

activity, as well as on characteristics of the wetland itself; and (3) treatment under Section 404 in some cases depends on the value of the wetland as perceived by resource management agencies and the Corps. Some of these problems could be overcome by site-specific investigations, but this is not practical for any sizable number of wetlands.

It may be possible, however, to classify wetlands into categories that are closely related to their status under Section 404 (see Table 4). For example, any regulated activity, regardless of extent, should require an Individual Permit if it is proposed to occur in a wetland adjacent to a stream with >5 cfs average annual flow. Classification of wetlands in this way requires: (1) an estimate of their size, (2) a determination of adjacency, and (3) for adjacent wetlands, an estimate of the average annual flow in the watercourse. In this study, sizes were calculated by computer from digitized versions of NWI maps. Wetlands adjacent to a stream with >5 cfs average annual flow were identified as those in the historic floodplain of the Cache La Poudre River. Additional work should be done to determine how closely the results of this interpretation correspond to those from procedures used by Corps personnel. Identifying wetlands above the headwaters was not a problem in this study because the Corps provided a list of streams and the uppermost location on those streams where average annual flows exceed 5 cfs. In other areas, this could be more difficult. However, Corps personnel make such determinations regularly, and there appears to be no reason that the same or similar procedures could not be used in a study of this nature.

The real question is whether classification of wetlands in a manner similar to that shown in Table 4 provides additional information that is useful to resource agencies. The original intent of classifying wetlands in this way was to provide some estimate of the relative rates of loss among the various categories. For example, if 20% of the wetlands normally covered by Nationwide Permit 26 were lost in a given period, while only 10% of the wetlands normally covered by Individual Permits were lost, that fact should be of interest to resource agencies. If it is, such information can be provided at a small additional cost relative to the total cost of a study of this kind (i.e., classifying wetlands as was done in this study is not very expensive). If it is not, the classification step could be omitted without affecting other parts of any future studies.

WETLAND ALTERATIONS

In this study, wetland alterations were determined by visiting each wetland shown on the 1975 NWI maps. This worked reasonably well in the Fort Collins area, where access (i.e., the road system) and visibility are good and where there are relatively few wetlands. In addition, this approach has the advantages of not requiring current aerial photography and of avoiding some of the inherent variability in photointerpreting, digitizing, and comparing two sets of maps. However, it also has several drawbacks. It does not necessarily provide an accurate estimate of "new" wetlands, because the entire study area is not systematically searched. Sizes of some alterations must be estimated in the field. The approach would be resource-intensive in a larger study area with more wetlands. And finally, there are potential trespass problems in examining wetlands, though none were encountered in this study.

An alternate approach that might be used in future studies of this nature would be to base all estimates of wetland changes on comparisons of two sets of maps. This approach would have its own advantages and disadvantages. It would provide reliable estimates of "new" wetlands, since the entire area would be covered, as well as estimates of the sizes of alterations. On the other hand, development of current wetland maps, if they do not exist, could be expensive, depending on size of the study area and density of wetlands. Causes of some alterations would likely be difficult to determine, and, if hydrologic conditions were very different at the times the two sets of photography were obtained, false conclusions about wetland changes could be drawn. Finally, inherent variability in photointerpretation and digitizing could also result in apparent changes in wetlands that actually have not changed.

A third approach that might have merit in some future studies would be to use two sets of maps to identify apparent wetland alterations and then to verify the apparent alterations with site visits. Criteria would have to be developed concerning how large a change would constitute an apparent alteration because it is unlikely that areas calculated from any two digitized versions of a wetland would be identical. If such criteria could be developed, this approach would avoid many of the problems associated with the other two approaches.

Based on the results of the present study alone, it is not possible to say which of these approaches would be best for any particular study area. Each has merits and drawbacks, and any decision among the three should be made on a case-by-case basis.

THE PERMIT RECORD

The current study revealed that it can be difficult to locate records of Section 404 permits. As might be expected, records of older permits were usually harder to locate than those from more recent ones, and records of Nationwide Permits were generally more difficult to find than those of Individual Permits. It is unknown whether this situation would be the same for other offices of the agencies involved, but it seems likely that the adequacy of the permit record would vary from place to place. It also seems likely that the permit record would be more complete for more recent time periods. Thus, it might be easier to conduct a study of this nature for the period, say, 1983-1988 (assuming the existence of aerial photography for 1983) than for the period 1977-1988.

COSTS

The costs of conducting additional studies of this nature would obviously be highly variable due to the uniqueness of each application, and would depend on factors such as: size of the study area (i.e., costs would generally increase with study area size, but there would also be economies of scale for some steps); density of wetlands in the study area; the exact approach used to examine alterations (e.g., baseline maps and intensive field work versus two sets of maps and limited field work); and the ease or difficulty of obtaining related documents. Table 5 summarizes our best estimates as to the costs that might be encountered under various circumstances, exclusive of overhead, travel, and miscellaneous costs such as copying and printing.

Table 5. Estimated costs of different approaches for determining the relationship between Section 404 and wetland losses.[a]

Task	Approach[b] A	B	C
Per quad:			
Aerial photography	Assume baseline exists	$80-$100 for current	$80-$100 for current
Photointerpretation and drafting	Assume baseline exists	$800-$1,200 for current	$800-$1,200 for current
Digitizing and data base construction	$200-$450 for baseline	$400-$900 for baseline and current	$400-$900 for baseline and current
Field examination	$1,000	No field examination	$80-$240
Per study area:			
Permit record acquisition	$400-$800	$400-$800	$400-$800
Data analysis and report preparation	$1,200-2,400	$1,200-$2,400	$1,200-$2,400

[a]Exclusive of costs for overhead, travel, copying, and printing.

[b]A = determine alterations from baseline maps and field check all wetlands.

B = determine alterations from two sets of maps only.

C = determine apparent alterations from two sets of maps and verify with site visits.

Studies of wetland trends depend on the existence of baseline data. We therefore assume the existence of wetland maps from the mid to late 1970's for any study area of interest. If these maps have to be digitized and a computerized data base generated, the cost would likely fall in the range of $200-$450 per 7½' quadrangle (quad), depending mostly on wetland density. Some economies of scale would be expected in the data base construction phase.

It took about 100 hours to examine all of the wetlands in the Fort Collins quad. At a labor rate of $10 per hour, the cost of this method of identifying wetland alterations would be about $1,000 per quad, assuming access and wetland densities similar to the Fort Collins area. We judge that this approach would not be feasible in areas with many more wetlands or poorer access. As discussed above, an alternate approach might be to use two sets of maps (baseline and current) to identify apparent alterations, with site visits only for verification of changes. Depending on the exact status of current information, costs for this approach might include $80-$100 per quad for aerial photography, $800-$1,200 per quad for photointerpretation and drafting, and $200-$450 per quad for digitizing and data base construction. Labor costs for field examination of alterations would depend on the number of alterations encountered. In most cases the alterations (as opposed to all of the wetlands) in a quad could probably be examined in 1-3 days, at a cost of $80-$240 per quad. Costs for this approach might vary considerably if it were necessary to examine some or all alterations from an aircraft.

The costs associated with obtaining relevant permit records, synthesizing the data, and preparing the results for publication are perhaps the most difficult to estimate. The ease or difficulty of obtaining the permit record would likely vary considerably from office to office, and would also depend somewhat on the size of the study area. For most study areas of reasonable size (5-10 quads), this could probably be accomplished in 1-2 weeks ($400-$800). Data synthesis and report preparation could probably be accomplished in 2-4 weeks, at a cost of $1,200-$2,400, assuming a slightly higher wage rate ($15 per hour) for these activities.

CONCLUSIONS

The primary objective of this study was to assess the feasibility of estimating wetland losses in relationship to their regulatory status under Section 404 of the Clean Water Act. To make this assessment, we attempted to obtain, for the Fort Collins quadrangle, information on: (1) wetland area that existed in the mid to late 1970's; (2) area lost since that time for which Individual or General Permits were issued; (3) area lost due to illegal activities; (4) area lost to unregulated activities; (5) area lost at locations considered by natural resource agencies as being wetlands but not so considered by the Corps; and (6) area gained through mitigation or other wetland creation or restoration activities. On the basis of this effort, we conclude that it is possible to obtain the desired information, with the following caveats.

1. The best data on wetlands that existed in the mid to late 1970's is likely to be in the form of NWI maps. Not all wetlands shown on these maps are considered jurisdictional wetlands by the Corps; jurisdictional wetlands in many cases can be identified only through site visits. Furthermore, if a wetland has been altered, in some cases it may not be possible to tell whether it would have been considered jurisdictional.

2. Treatment of wetlands under Section 404 depends not only on characteristics of the wetland itself, but also on the nature and extent of the proposed development activity. Thus, given map-based information alone, it is not possible to classify wetlands as to their treatment under Section 404. However, it appears that it is possible to classify wetlands into categories that are closely related to Section 404, and thus to provide some information on relative rates of loss.

3. The permit record may at times be incomplete, or at least difficult to trace. This makes it difficult to identify illegal activities with certainty in the absence of direct interactions with the landowner/developer.

4. Causes of some alterations, and thus their regulatory status under Section 404, can sometimes be difficult to determine after the fact (e.g., whether or not a discharge of dredged material occurred in association with drainage).

Given these caveats, however, it appears that it is possible to develop the kinds of information presented in this report for larger geographic areas. Whether it is desirable and cost-effective to obtain such information can only be determined by personnel in operational branches of the Service and other resource agencies.

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APPENDIX

Code	Meaning
L1OWKZ	Lacustrine, limnetic, open water, artificial, intermittently exposed/permanent
L2OWKZ	Lacustrine, littoral, open water, artificial, intermittently exposed/permanent
PEM/FLW	Palustrine, emergent, flat, intermittently flooded/temporary
PEMC	Palustrine, emergent, seasonal
PEMW	Palustrine, emergent, intermittently flooded/temporary
PEMY	Palustrine, emergent, saturated/semipermanent/seasonal
PFLKC	Palustrine, flat, artificial, seasonal
PFLKY	Palustrine, flat, artificial, saturated/semipermanent/seasonal
PFLW	Palustrine, flat, intermittently flooded/temporary
PFLY	Palustrine, flat, saturated/semipermanent/seasonal
PFOW	Palustrine, forested, intermittently flooded/temporary
POWF	Palustrine, open water, semipermanent
POWKF	Palustrine, open water, artificial, semipermanent
POWKH	Palustrine, open water, artificial, permanent
POWKZ	Palustrine, open water, artificial, intermittently exposed/permanent
POWZ	Palustrine, open water, intermittently exposed
PSS/EMC	Palustrine, scrub/shrub, emergent, seasonal
R2BBW	Riverine, lower perennial, beech/bar, intermittently flooded/temporary
R2OWZ	Riverine, lower perennial, open water, intermittently

APPENDIX (Concluded)

Code	Meaning
R4SBKC	Riverine, intermittent, streambed, artificial, seasonal
R4SBW	Riverine, intermittent, streambed, intermittently flooded/temporary

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The primary objective of this study was to determine the feasibility of estimating wetland losses for a relatively small geographic area in relationship to Individual and General Permits issued under Section 404 of the Clean Water Act. The study attempted to obtain information on: (1) wetland area that existed at about the time of enactment of the Clean Water Act of 1977; (2) area lost since that time for which Individual or General Permits were issued; (3) area lost due to illegal activities; (4) area lost to unregulated activities; (5) area lost at locations considered by natural resources agencies as being wetlands but not so considered by the Corps of Engineers; and (6) area gained through mitigation or other wetland creation or restoration activities. The study showed that it is generally feasible to obtain such information, but with some limitations.

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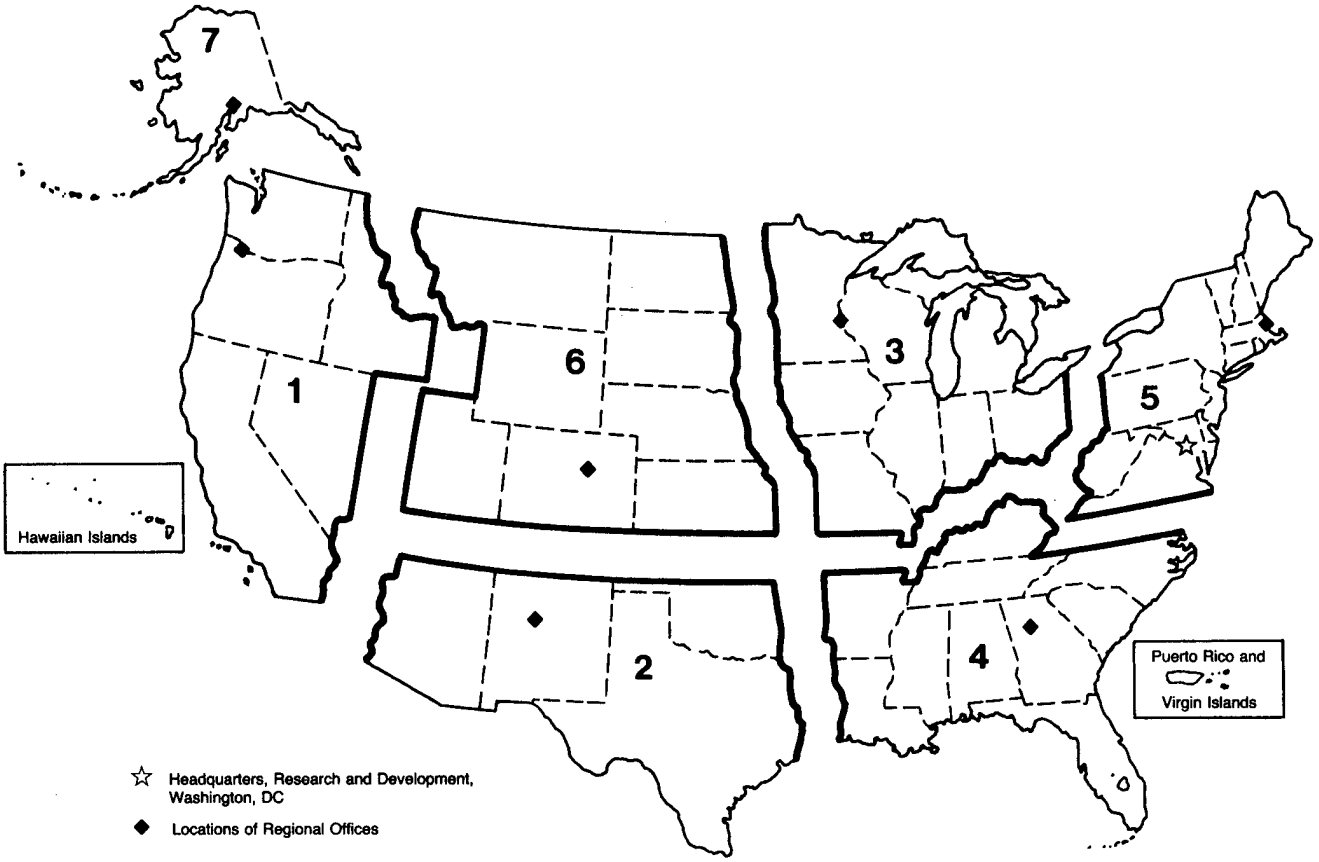

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